RECITATION 6

Ch. 7

••5 A father racing his son has half the kinetic energy of the son, who has half the mass of the father. The father speeds up by 1.0 m/s and then has the same kinetic energy as the son. What are the original speeds of (a) the father and (b) the son?

a)

$$m_F = 2\, m_S$$

Also,

$$K_F = K_S/2$$

$$\frac{1}{2} m_F v_F^2 = \frac{1}{2}\left(\frac{1}{2} m_S v_S^2\right) \Longrightarrow v_F = \frac{1}{2} v_S$$

$$K_{F,2} = 2K_F$$

$$v_{F,2} = v_F + 1.0$$

$$\frac{1}{2}m_F(v_F + 1.0)^2 = 2\left(\frac{1}{2}m_F v_F^2\right)$$

Solving for v_F gives

$$v_F = \frac{-1}{1 \pm \sqrt{2}} = 2.4\ \frac{\text{m}}{\text{s}}.$$

Note that we selected the negative root to have v_F (the magnitude of any vector is always positive).

b)

$$v_S = 2v_F = 4.8\frac{\text{m}}{\text{s}}.$$

•9 The only force acting on a 2.0 kg canister that is moving in an xy plane has a magnitude of 5.0 N. The canister initially has a velocity of 4.0 m/s in the positive x direction and some time later has a velocity of 6.0 m/s in the positive y direction. How much work is done on the canister by the 5.0 N force during this time?

$$\Delta K = W$$

$$K_i = \frac{1}{2} m\, v_i = \frac{1}{2}(2.0)(4.0)^2 = 16\text{ J.}$$

$$K_f = \frac{1}{2} m\, v_f = \frac{1}{2}(2.0)(6.0)^2 = 36\text{ J.}$$

$$W = 36\text{ J} - 16\text{ J} = 20\text{ J.}$$

•17 SSM WWW A helicopter lifts a 72 kg astronaut 15 m vertically from the ocean by means of a cable. The acceleration of the astronaut is $g/10$. How much work is done on the astronaut by (a) the force from the helicopter and (b) the gravitational force on her? Just before she reaches the helicopter, what are her (c) kinetic energy and (d) speed?

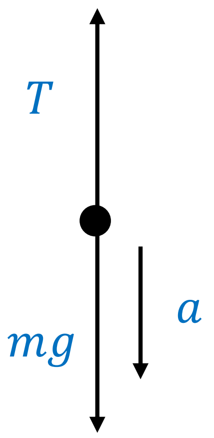
a)

$$T - mg = m(g/10)$$

$$T = \frac{11}{10}mg = 777 \text{ N}.$$

$$W_T = \vec{T} \cdot \vec{d} = Td\cos 0 = (777 \text{ N})(15 \text{ m})(1) = 11.7 \text{ kJ}$$

$$\approx 12 \text{ kJ}.$$



b)

$$W_g = \vec{F}_g \cdot \vec{d} = F_g d \cos\pi = -mgd = -(72\text{ kg})\left(9.81\ \frac{\text{m}^2}{\text{s}}\right)(15\text{ m})$$

$$= -10.6\text{ kJ}$$

$$\approx -11\text{ kJ}.$$

c)

$$\Delta K = W$$

$$K_f = K_i + W = W = W_T + W_g$$

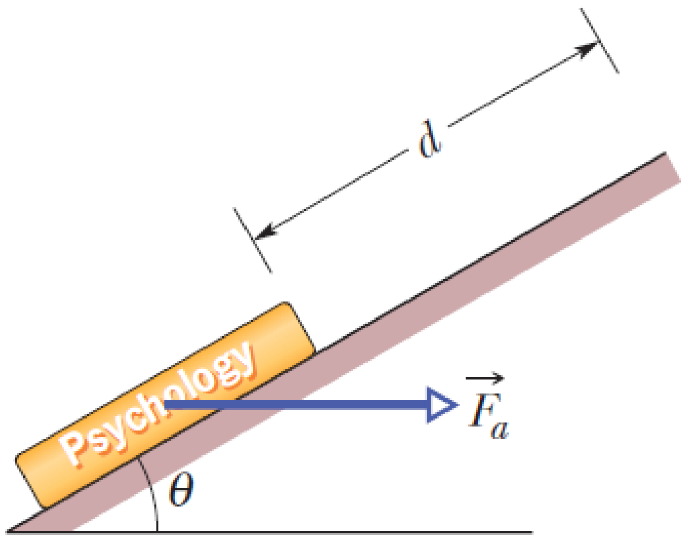
$K_i = 0$ because $v_i = 0$

$$K_f = 11.7\text{ kJ} - 10.6\text{ kJ} = 1.1\text{ kJ}.$$

d)

$$K_f = \frac{1}{2} m\, v_F^2 \Longrightarrow v_F = \sqrt{\frac{2K_f}{m}} = \sqrt{\frac{2(1.1\text{ kJ})}{72\text{ kg}}} = 5.5\text{ m/s}.$$

••24 In Fig. 7-32, a horizontal force $\vec{F}_a$ of magnitude 20.0 N is applied to a 3.00 kg psychology book as the book slides a distance $d = 0.500$ m up a frictionless ramp at angle $\theta = 30.0°$. (a) During the displacement, what is the net work done on the book by $\vec{F}_a$, the gravitational force on the book, and the normal force on the book? (b) If the book has zero kinetic energy at the start of the displacement, what is its speed at the end of the displacement?

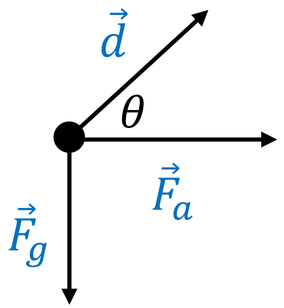


a)

$$W_{F_a} = \vec{F}_a \cdot \vec{d} = F_a d \cos\phi = (20.0\ \mathrm{N})(0.500\ \mathrm{m})\cos 30.0°$$
$$= 8.66\ \mathrm{J}.$$

b)

$$\Delta K = K_f - 0 = \frac{1}{2} m\, v_f^2 = W_{net} = W_g + W_{F_a}$$
$$v_f = \sqrt{2W_{net}/m}$$
$$W_g = \vec{F}_g \cdot \vec{d} = F_a d \cos\phi = mgd\cos\phi$$
$$= (3.00\ \mathrm{kg})(9.81\ \mathrm{m/s^2})(0.500\ \mathrm{m})\cos 120°$$
$$= -7.36\ \mathrm{J}.$$
$$W_{net} = -7.36\ \mathrm{J} + 8.66\ \mathrm{J} = 1.30\ \mathrm{J}.$$
$$v_f = \sqrt{\frac{2(1.30\ \mathrm{J})}{3.00\ \mathrm{kg}}} = 0.931\ \mathrm{m/s}.$$



••31 SSM WWW The only force acting on a 2.0 kg body as it moves along a positive x axis has an x component $F_x = -6x$ N, with x in meters. The velocity at $x = 3.0$ m is 8.0 m/s. (a) What is the velocity of the body at $x = 4.0$ m? (b) At what positive value of x will the body have a velocity of 5.0 m/s?

a)

$$K_f = K_i + W$$

$$\frac{1}{2} m\, v_f^2 = K_i + W \implies v_f = \sqrt{\frac{2(K_i + W)}{m}}$$

$$W = \int_{x_i}^{x_f} F_x dx = -6\int_{3.0}^{4.0} x dx = -6\left[\frac{1}{2}x^2\right]_{3.0}^{4.0} = -21 \text{ J}.$$

$$K_i = \frac{1}{2}mv_i^2 = \frac{1}{2}(2.0)(8.0)^2 = 64 \text{ J}.$$

$$v_f = \sqrt{\frac{2(64 \text{ J} - 21 \text{ J})}{2.0 \text{ kg}}} = 6.6 \text{ m/s}.$$

b)

$$K_f = \frac{1}{2}mv_i^2 = \frac{1}{2}(2.0)(5.0)^2 = 25 \text{ J}.$$

$$W = \Delta K = 25 \text{ J} - 64 \text{ J} = -39 \text{ J}.$$

$$W = \int_{x_i}^{x_f} F_x dx = -6\int_{3.0}^{x_f} x dx = -6\left[\frac{1}{2}x^2\right]_{3.0}^{x_f} = 27 - 3x_f^2.$$

Setting $27 - 3x_f^2$ equal to -39 J and solving for x_f gives

$$x_f = 4.7 \text{ m}.$$